Reply to the comments of Chu *et al.* on O. J. Orient and A. Chutjian, in *Phys. Rev. Lett.* *74*, 5017 (1995).

Orient and Chutjian Reply: We thank the authors for their critique of our paper on O^-/NO production *via* dissociative attachment (DA) [1]. They have raised a number of questions [2] on our experimental conditions which we address here.

Voltages and Magnetic-Field Intensities: The reason for use of a high magnetic field B was to raise the space-charge limited currents available at the attachment region. This was partly historical in nature, as the instrument was used for generating high fluxes of fast, neutral O-atom beams [3]. Use of the higher B-field naturally entails use of a higher E-field since the drift velocity is given by $v_D = E/B$ (m/sec), as noted by Chu, *et al.* We have carried out to date a fully three-dimensional fields-and-trajectories modeling of the collision region and the trochoidal monochromator TM. Calculations were done using two separate three-dimensional codes. One code included full space charge, the other neglected space charge. At the currents reported here, no space charge effects were observed for either the electron or ion beams. The main effect in use of the higher fields is to increase the fringing effects at the entrance to TM (see Fig. 1 of Ref. 1). The fringing at the TM entrance serves as an aperture, in addition to the 3-mm dia physical aperture at the entrance to TM. Both "apertures" restrict the range of gyroradii of the O^- ions entering the full length of TM. The values of E and B impressed on the charged particles were the values needed to direct the particles into their designated paths. For a 1-eV O^- ion these values were 1.2×10^4 V/m and 6.0 tesla. They were set by the full 3-D calculations which included fringing, beam shear, field-penetration, and lens-aberration effects for our specific experimental geometry.

Electron and Ion Currents and Their Ratios: The two problems here are our use of the word "typical" in describing the currents of electrons (10^{-5} A) and ions (10^{-9} A); and in specifying the pressure near the NO beam (6.7×10^{-7} Pa). We did not consider *exact* currents to be of interest to the reader , other than that we were in a linear region with respect to currents and gas pressure. Hence specific values were not given. Also, the pressure of 6.7×10^{-7} Pa was measured at a Bayard-Alpert gauge not at the hypodermic needle (used as the NO source). From the dimensions of the needle (length = 45 mm, diameter = 1 mm), one can estimate a gas density at the electron beam-NO intersection of about $n \approx 5 \times 10^{12}$ cm^{-3} [4]. The attenuation of the electron beam is then $\Delta I/I_o = n\, \sigma_{DA}\, \ell$, where $\sigma_{DA} = 1.15 \times 10^{-18}$ cm^2 is the DA cross section, and $\ell = 4$ mm is our interaction path length (estimate). Combining all values one gets an attenuation of 2×10^{-6}, which is greater than the "9-10 orders of magnitude" cited by Chu, *et al.* A better estimate from our experimental conditions would be $5 \times 10^{-10}/10^{-5} = 5 \times 10^{-5}$.

Electron Energy Width: We have used a symmetrically-biased, hairpin tungsten filament as the electron emitter. Emission occurs from the spatially-confined hairpin tip. The voltage drop is calculated to be less than 0.1 eV, and use of an estimated color temperature of the tip gives a reasonable width of 0.4 eV (FWHM). This is also close to a measured width of 0.51 eV in another (electrostatically-confined) electron gun used by us previously [5]. In any case, the electron energy width makes a very small contribution to the laboratory O^- energies (see shaded bars in Fig. 2 of Ref. 1), and is of negligible import here.

In the past year we have studied another well-known system, the dissociative attachment process H^-/H_2. The results can be explained in terms of the angular broadening due to the DA kinematics, and to DA from vibrationally-excited $H_2(v'')$ [6]. Work in progress includes studies of two other well-known systems, O^-/CO and O^-/O_2 These studies will include a full 3-D modeling of the collision region and of the trochoidal monochromator dispersion.

References:

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[5] M. T. Bernius, K-F. Man and A. Chutjian, *Rev. Sci. Instr. 59*, 2418 (1988).

[6] O. J. Orient and A. Chutjian, manuscript in preparation.

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